# Space Weather Technical Forecast

Issued on Wednesday, 13 March 2024 at 13:13 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: Chance of M-flares (R1/R2 Radio Blackouts), reducing into the UTC weekend.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Low, with isolated C-class X-ray activity recorded. There are four numbered regions and three as yet unnumbered regions on the visible disc. AR3599 remains the largest and most complex group, with a north-south aligned delta region in its large leading portion, as it approaches the western limb. AR3607 in the southeast, has displayed a spreading trend, now with small intermediate spots. AR3606 in the northeast remains largely unchanged. The remaining spots are all small and simple at present.

There were no Earth directed CMEs observed in the past 24 hours.

**Solar Wind / Geomagnetic Activity:** Solar wind speeds observed at L1 by ACE were fairly steady at slightly elevated levels (400-480 km/s). The solar wind density was generally below average. The Interplanetary Magnetic Field (IMF), Bt, was on a gradual rising trend but remained weak, rising from 4nT to 8nT through the period, with a north-south component, Bz, varying weakly between +6 and -7nT, gradually changing from mostly positive, to largely negative. The phi angle was mostly positive (away from the Sun). Geomagnetic activity was mostly Quiet (Kp 1-2), with two Unsettled (Kp 3) intervals to end the period.

**Energetic Particles / Solar Radiation:** GOES18 high energy (greater than 10MeV) proton flux remained at background throughout.

High energy electron flux (greater than 2MeV) observed at GOES16 started mostly at Moderate levels, with a peak of 555pfu at 12/1725UTC before gradually becoming background. The observed 24-hour fluence showed a declining trend, with the 24-hour integrated fluence value at 13/0000 UTC being 2.51e7 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** There is a daily Chance of M-class flares, most likely from AR3599. This sunspot is expected to remain on the Earth-facing side until the end of the current UTC working week, whereupon the risk of Moderate activity should fall.

**Solar Wind / Geomagnetic Activity:** A CME associated with the M7.4 flare from 10 March may pass Earth as a glancing blow later on Day 1 (13 Mar) or perhaps during Day 2 (14 Mar).

Coronal hole fast wind activity is likely to be modest in the period, with a weak connection to CH09/+ possible on Days 1- 2 (13-14 Mar).

Mostly Quiet to Unsettled conditions are therefore expected over the next few days, with a slight chance of Active/G1 Minor Geomagnetic Storm on days 1 and 2 should the 10 Mar CME and coronal hole fast wind materialise.

**Energetic Particles / Solar Radiation:** GOES18 high energy proton flux is expected to persist

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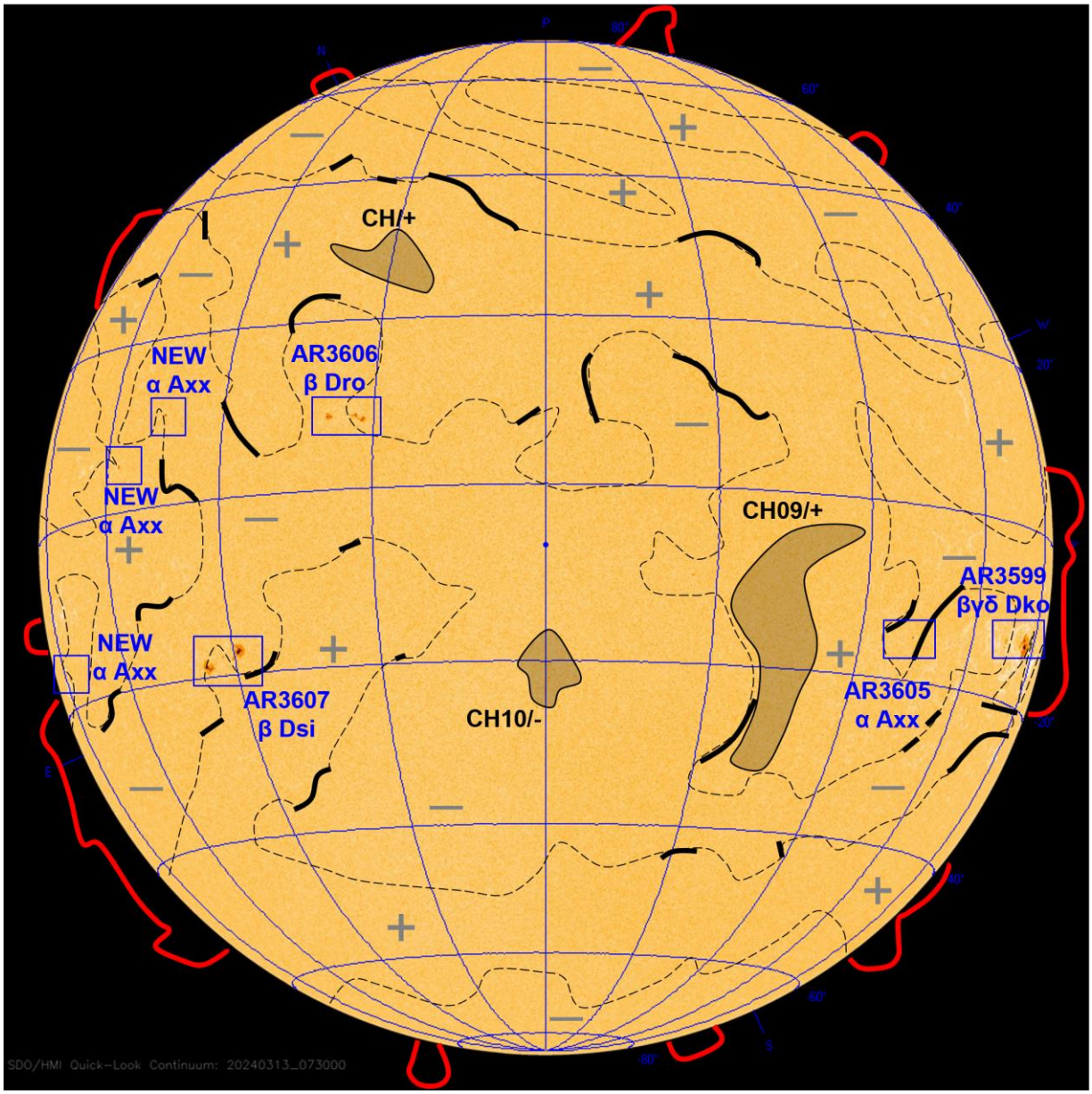
at background or close to background levels, with a very slight chance of S1 radiation storms, with the main risk from AR3599.

GOES16 high energy electron flux is likely to remain near its current diurnal Moderate oscillation in the near term, with electron counts perhaps seeing a response at GEO upon the passage of the 10 March CME on Days 1-2 (13-14 Mar) however this is deemed low confidence. Hence, 24-hr integrated fluence is likely to remain below the Active threshold.

**Figure 1. Solar Analysis Valid 13/0800 UTC**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

There is one CME in the forecast, the M7.4 CME of 10 March, with this signalled to pass largely above and ahead of the track of the Earth in its orbit either late on Day 1 (13 Mar) or early on Day 2 (14 Mar). MOSWOC Enlil and its ensembles suggest there is a slight chance of a glancing blow as it passes Earth, albeit with low confidence.

The fast wind aspect of the forecast is also of relatively low confidence, with none of the current cohort of coronal holes particularly well-formed or having strong links to previous rotations. A connection from CH09/+ may occur through Days 1-2 (13-14 Mar), possibly combining with any CME arrival, however as this coronal hole is of a positive polarity it does not lend itself to producing a strong connection given the time of year and hence should have limited effects. A small negative polarity coronal hole, CH10/- may come into effect later on Day 4 (16 Mar) but this is low confidence at this point.

Mostly Quiet to Unsettled conditions are therefore expected over the next few days, with a slight chance of Active/G1 Minor Geomagnetic Storm on days 1 and 2 should the 10 Mar CME and coronal hole fast wind materialise

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 20 | 20 | 5 | 5 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 11/0145 UTC | Partial | M7.4 from AR3599 | NW quadrant | 300 km/s | 14/0000 UTC | Glancing blow, low confidence. |

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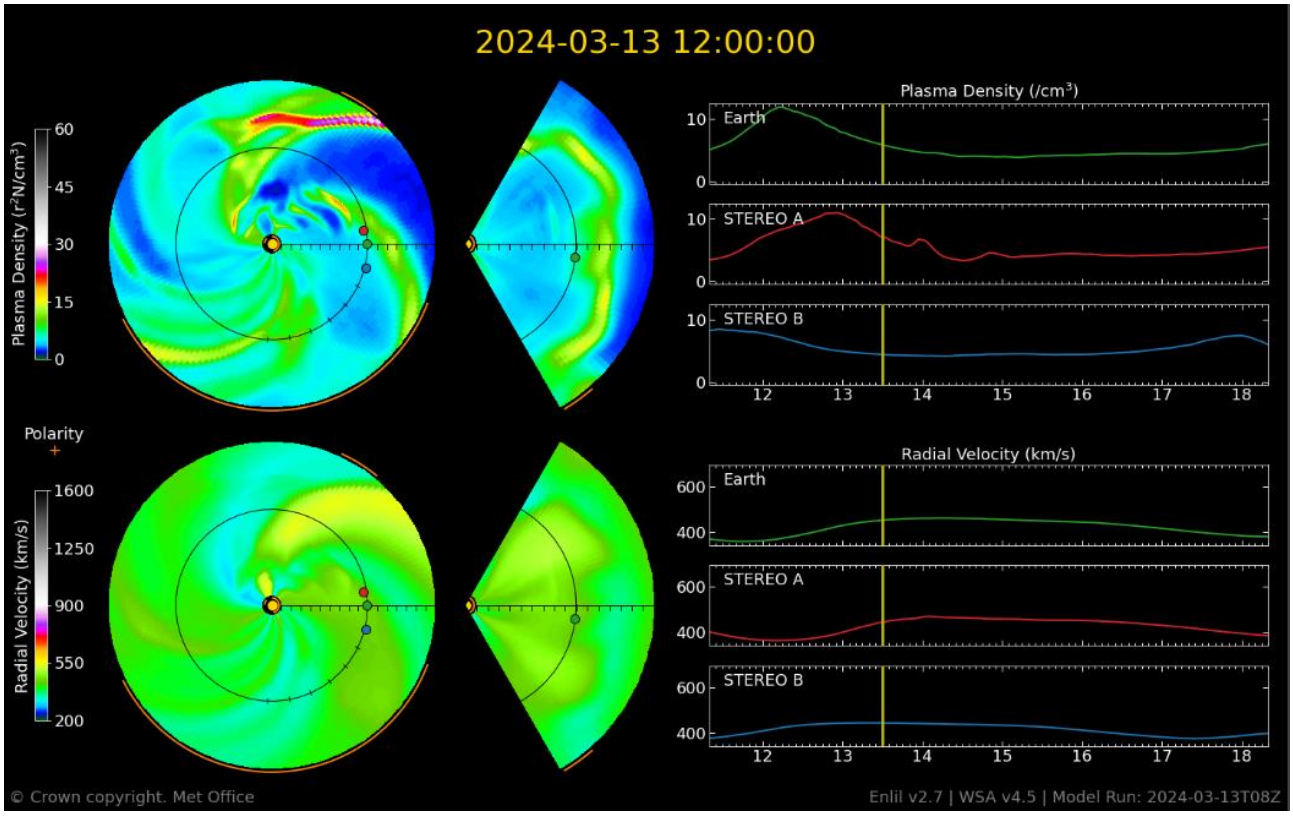
**Figure 2: MOSWOC ENLIL**

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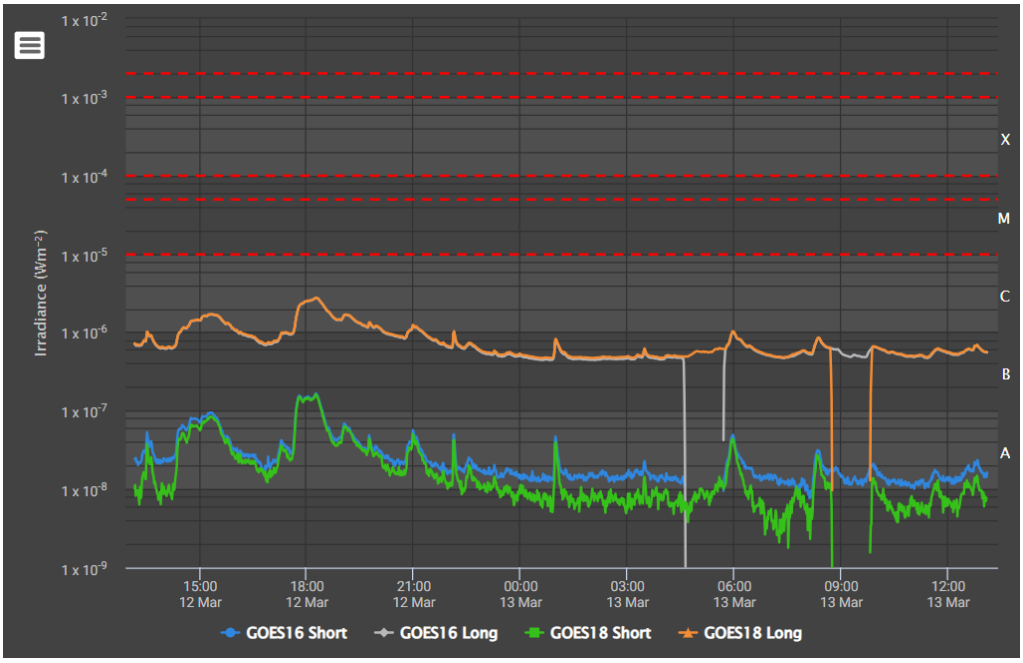
## Radio Blackouts - X-Ray Flares:

There are four numbered regions and three as yet unnumbered regions on the visible disc. AR3599 remains the largest and most complex group, with a north-south aligned delta region in its large leading portion, as it approaches the western limb, accurate analysis is becoming increasingly difficult due to foreshortening effects. AR3607 in the southeast, has displayed a spreading trend, now with small intermediate spots. AR3606 in the northeast remains largely unchanged though has now been reclassified as a simpler region with rudimentary penumbra. The remaining spots are all small and simple at present.

The X-ray flare forecast for the coming days mainly comes from the AR3599 sunspot region, and its passage around the western limb which is expected in the coming days. There remains a Chance of M-class flares, mainly from this region, with the risk then diminishing as it rotates around the limb. No significant returning regions are expected, albeit there may be a more active region rotating around the southeastern in the next few days, with magnetic looping and minor flare activity visible in imagery.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 30 | 30 | 20 | 20 |
| Very Active | R3 to R5 X Class | No | 5 | 5 | 1 | 1 |

**Figure 3: 24 hour X-ray trace**

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## Solar Radiation Storms - (High Energy Protons):

GOES18 proton flux levels are very closely tied to developments in AR3599, with no other sunspot groups of note. This feature proved capable of a very slight enhancement at GOES18 on 10 March in the wake of the M7.4 flare. The risk of S1+ therefore remains through the period as AR3599 advances to the western limb and slightly beyond in the coming four days.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Active | ≥ S1 | No | 5 | 5 | 5 | 5 |
| Very Active | ≥ S3 * | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

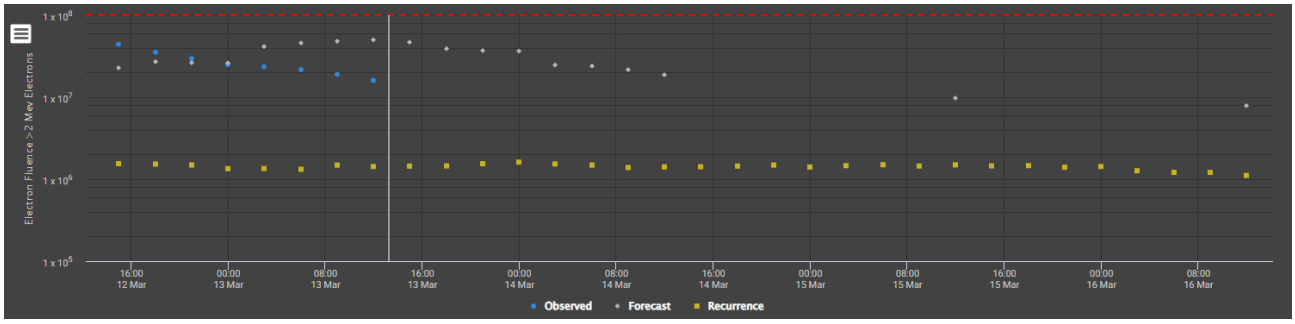
## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has shown a slight reaction to the recent CH07/- fast wind with flux levels reaching diurnal Moderate levels.

Further response of the electron belt could occur upon the possible passage of the 10 Mar CME arrival as well as CH09/+ coming into play, but both of these features are low confidence and are expected to have low impacts, hence any electron response is deemed unlikely. As a result, 24-hr integrated fluence is likely to remain below the Active threshold with only a slight chance of reaching this should the CME/coronal hole fast stream arrivals occur.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 1 | 10 | 10 | 5 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

**Figure 4: MOSWOC REFM, integrated fluence forecast, observations, recurrence.**

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